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This study attempts to identify the variables which contribute to patient waiting time in the emergency room. There are 10 independent variables that have been identified from previous studies found in the literature. These variables are patient volume, patient acuity, laboratory tests, radiology procedures, consultations, admission, physician staffing, nurse staffing, physician assistant staffing, and shift. Time and motion studies were conducted to quantify these variables for analysis. Correlation and stepwise multiple regression analysis were used to analyze the data and determine which variables made a statistically significant contribution toward patient waiting time.

The analysis identified laboratory tests, radiology procedures, and consultations as the variables having the strongest relationship to and predictive ability of patient waiting time. The results of these analyses will be used to make recommendations for changes in the emergency room or related services that would improve the efficiency and quality of services provided in the emergency room.
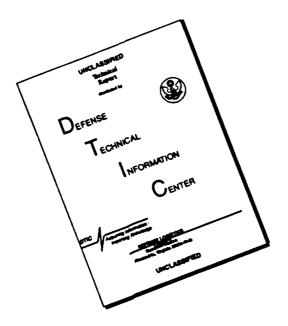
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AN ANALYSIS OF PATIENT WAITING TIME IN THE EMERGENCY ROOM
AT MARTIN ARMY COMMUNITY HOSPITAL, FORT BENNING, GEORGIA

A Graduate Management Project

Submitted to the Faculty of

Baylor University

In Partial Fulfillment of the

Requirements for the Degree

of

Master of Health Administration

by

Captain Rolando Castro Jr., MS

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Abstract

This study attempts to identify the variables
which contribute to patient waiting time in the
emergency room. There are 10 independent variables
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recommendations for changes in the emergency room or
related services that would improve the efficiency and
quality of services provided in the emergency room.

Introduction

Patient flow and long patient waiting times are important aspects of efficiency in the emergency room. The efficient use of emergency room resources can have a significant impact upon patient satisfaction, hospital public relations, quality of care, and cost containment. Understanding and quantifying the variables involved in this process can be beneficial in analyzing and improving efficiency. For the purpose of this study, patient waiting time is defined as the total amount of time the patient spends in the emergency room from the time the patient registers at the front desk to the time of final disposition. The terms emergency room (ER), emergency department (ED), and emergency unit (EU) are used interchangeably.

Conditions Which Promted the Study

The administration at Martin Army Community Hospital (MACH) monitors the status of patient waiting time in the ER on a daily basis. The hospital commander has set a goal of no more than three hours from the time the patient presents to the ER until final disposition. Over the period from January 1, 1992, to November 30, 1992, MACH averaged 10.38 patients per day with waiting times greater than

three hours.

During the first 10 months of 1992, there were 81 patient complaints filed against the MACH emergency room. Twenty-three of these complaints, or slightly more than 28%, involved patient waiting time. Long waiting times in the emergency room are often a source of patient dissatisfaction and give negative perceptions of the quality of patient care rendered. This perception impacts on the reputation of both the emergency room and the hospital. More importantly, long waiting times may delay the initiation of treatment for genuine emergencies, making waiting time a quality assurance issue. An understanding of how patients flow through the system and the multiple factors that affect patient waiting time may provide a basis for improving efficiency and the quality of patient services in the emergency room. As the Department of Defense (DoD) continues to reduce the force structure, DoD medical treatment facilities (MTF) will see reductions in their annual budgets, with little or no decrease in the beneficiary population they must serve. The current budgetary constraints on DoD medical treatment facilities require more efficient use of resources in order to operate within the annual

budget. For MACH, the emergency room will play an important role in this effort. The ER averages approximately 48,000 emergency room visits per year and accounts for approximately 25% of inpatient hospital admissions.

Statement of the Management Problem

Patient flow and long patient waiting times in the emergency room are important aspects of efficiency that impact upon patient satisfaction, hospital public relations, quality of care, and cost containment. What are the factors which contribute to patient waiting time in the emergency room and how can these factors be addressed to improve the quality and efficiency of patient services?

Literature Review

A review of the literature on waiting time in the emergency room shows that past studies have examined numerous factors in an ef'ort to determine the causes inherent to this problem. These factors can be classified into three general areas: structural, patient, and process variables. Structural variables include size and/or type of emergency department, layout or unit design, staffing levels, and skill levels of providers. The primary patient variable

studied is patient acuity or classification. Other
patient variables include age, gender, and beneficiary
status. Process variables involve patient flow and
look at the time it takes to complete registration,
triage, treatment, diagnostic testing, consultation,
admission, or discharge.

A retrospective study by Howell, Torma, Teneyck,
Burrow, and Huang (1990) of 17,028 emergency room
records compared patient waiting times with two methods
of physician staffing. The study looked at two
distinct time periods: December 1, 1986, to March 31,
1987 (phase 1), and December 1, 1987, to March 31, 1988
(phase 2). During phase 1 the emergency department was
staffed with five experienced emergency physicians (EP)
and was supplemented with physicians from other
hospital departments. During phase 2, the ER was
staffed with six experienced EPs and supplemented with
physicians from other hospital departments. A
statistical comparison using a two-tailed t-test
revealed a statistically significant difference
($p < 0.00001$) in time waited to be seen by a physician
and time waited for discharge between phase 1 and
phase 2. Patients during phase 1 waited 25.6 minutes
to see a physician compared to 13.7 minutes during

phase 2.   The waiting time to discharge in phase 1 was 71.9 minutes and 59.5 minutes in phase 2.   Howell et al. concluded staffing the ER with more experienced EPs significantly reduced patient waiting time.

A time and motion study by Saunders (1987) tracked 1,568 patients through the emergency department to identify sources of delay.   Saunders found that patients of high acuity had the shortest waiting times in all stages of the emergency patient encounter, while the patients of low acuity experienced the longest waits, especially when diagnostic tests had to be performed.

A study by Smeltzer and Curtis (1986) analyzed process variables and patient acuity in an attempt to establish criteria for correcting inefficiencies in the emergency department.   They reviewed 171 patient records to determine the amount of time each patient spent in triage, examination/treatment, and awaiting discharge.   Each patient was assigned an acuity code ranging from 0 to 6 (least urgent to cardiac arrest).   They also noted whether the patients had laboratory or radiology procedures, consultations, or were admitted to the hospital.

They found the average waiting time to be 150.16

minutes. The average time spent in triage was 15.38

minutes. The average time spent in the examination or

treatment room was 2.12 hours. The average time spent

awaiting discharge was 10.03 minutes. Approximately

49% of the patients were discharged within the first

two hours, 25% discharged between two and three hours,

and 26% discharged after three hours. Of the latter

group, 28 out of 45 patients had waiting times greater

than four hours. All but two of the 28 patients had

some combination of laboratory procedures, radiology

procedures, and/or consultations. Eleven of the 28

patients were admitted to the hospital.

Most of the patients (91%) that presented to the

emergency room were classified as acuity code 2 or 3

(minor or major care). Approximately 6% of the

patients presented with life-threatening conditions or

cardiac arrest (acuity codes 5 and 6). Smeltzer and

Curtis found that there was no correlation between

acuity and patient waiting time.

They concluded that long waiting times appear to

be related to diagnostic testing, consultations, and

admission to the hospital, but were not able to

directly assess the contribution to long waiting time

since the amount of time taken for these procedures was

not recorded.

In 1987, Smeltzer and Curtis conducted a subsequent study of patient waiting time. The second study involved time and motion studies to determine the factors that contributed to the long waiting times discovered in the previous study. This second study revealed that the average time for ordering a laboratory test and receiving the results was 77.6 minutes. The average length of time for a radiology exam was 69.02 minutes. Consultations required an averaged of 63.36 minutes. An analysis of admissions showed that the average waiting time in the emergency room for patients who were admitted was 4.55 hours. The average waiting time from when the admissions office was notified until the patient was transported to the ward was 1.5 hours.

DiGiacomo and Kramer (1982) investigated the relationship between daily patient census, patient arrival rate, and mean patient waiting time. They speculated that patients had to wait longer on busier days. Using Spearman's Rho, they found that there was not a significant correlation between waiting time and patient volume (ER census). An analysis of variance showed that only 15% of the variation in waiting time

was due the patient volume. Comparisons between

waiting time and hourly patient arrival rates showed no

significant correlation and a 22% variance in waiting

time attributable to hourly patient arrival rates.

Based on an average waiting time of 78 minutes, the

regression equation indicated that 59% of the patient's

time was spent being processed through the system and

the remaining 41% was the time spent waiting between

the various steps of the process.

This study also identified staffing levels and

patient acuity as other factors that delay patient

waiting time, but did not attempt to quantify these

variables. After these problems were identified,

modifications were made in an attempt to improve

patient waiting time. The authors conducted two more

studies of waiting time after the changes were

implemented and found that the modifications in

staffing and illness-related resource availability

reduced the total visit time by 12%.

Wilbert (1984) conducted a study identifying

diagnostic tests, consultations, and the educational

level of physicians as factors affecting the length of

patient visits to the emergency room. The study failed

to show any statistically significant relationship

between patient acuity and total visit time, day of the week, or shift, or between time from arrival to physician contact and total visit time. Total visit time averaged 126.9 minutes.

Purnell (1991) conducted a survey of 185 hospitals in the mid-Atlantic region which reported that 62% of these facilities had average waiting times in the emergency room of greater than one hour, but less than two hours. Fifteen percent had average waiting times between two and three hours. Only 5% reported average waiting times over three hours. A statistical analysis of the survey results revealed a significant difference (Chi-squared, $p < 0.005$) in the waiting times between facilities with a fast-track system and those without such systems.

Goss, Reed, and Ready (1971) in their survey of New York Hospital found that there was no significant relationship between patient volume and patient waiting time. However, they did discover a significant correlation between median waiting time to see a physician and patient volume per shift.

In a retrospective study of 895 admissions from the emergency room at Silas B. Hayes Army Community Hospital, Schloss (1991) discovered that patient

acuity, patient volume, and admitting service were statistically significant factors (p< 0.0001) contributing to the total time required for a patient to be admitted through the emergency room. The study showed that the mean total time for admission was 183 minutes. Patients triaged as `emergent` had the lowe. mean total times and patients triaged as `non-urgent` had the highest mean total times. Psychiatric admissions had the lowest mean total times and pediatrics, surgery, and obstetrics-gynecology were grouped as having the highest mean total times.

In 1978, Cue and Inglis conducted a study of the emergency departments in 20 Washington, D.C., area hospitals. The study analyzed treatment times, x-ray and laboratory turnaround times, staffing levels, and facility design. They found that total patient waiting time varied significantly among small community, suburban, and urban hospitals, with mean times of 67, 90, and 133 minutes, respectively. X-ray examinations were performed on approximately 40% of the patients with a mean turnaround time of 44 minutes. Laboratory tests were performed on less than 30% of the patients with an average turnaround times of 55 min es. Their analysis of these turnaround times indicated only a

slight correlation with waiting time.

In summary, past studies have shown that there are numerous factors that affect patient waiting time. These studies reveal a wide variance in the statistical significance of these factors and in some cases even contradictory findings. Despite these inconsistencies in the literature, most of the studies identified diagnostic tests, consultations, and admission as significant factors influencing patient waiting time.

Purpose

The purpose of this study was to determine which factors contribute to patient waiting time in the emergency room and how these factors can be addressed to improve the quality and efficiency of patient services.

The objectives of the study were:

(1) analyze patient flow in the emergency room to identify the key variables affecting patient waiting time;

(2) conduct time and motion studies to quantify the variables affecting patient waiting time;

(3) conduct statistical analyses of the resulting data from the time and motion studies; and

(4) use the results of the analysis as a basis for

recommending changes to improve efficiency and quality
in the emergency room.

The dependent variables in this study are time
from registration to triage, time from triage to
physician encounter, time from physician encounter to
final disposition, and total patient waiting time.
However, only the aggregate measure (total patient
waiting time) will be used in the hypothesis test.
There are 10 independent variables identified: patient
volume, patient acuity, laboratory tests, radiology
procedures, consultations, admission, physician
staffing, nurse staffing, physician assistant
staffing, and shift.

The null hypothesis in this study states that
patient waiting time does not vary as a function of
patient volume, patient acuity, laboratory tests,
radiology procedures, consultations, admission,
staffing, or shift.

The alternate hypothesis in this study states that
patient waiting time does vary as a function of patient
volume, patient acuity, laboratory tests, radiology
procedures, consultations, admission, staffing, or
shift.

Methods and Procedures

This study employed a quantitative, non-experimental research design using data collected from ER logs, work schedules, and Standard Forms 558 (SF 558), Emergency Care and Treatment. Data collection for this study took place during a two week period from January 15, 1993, through January 28, 1993.

The data collection yielded an initial sample of 1806 subjects. From this sample, 25 subjects were randomly selected for each day of the two week period for which data was collected, yielding a final sample of 350 subjects (N=350). The alpha probability level was set at $p < 0.05$.

Time and motion data were collected on each patient that presented to the emergency room during this period. As the patient was processed through the ER system, times were recorded on SF 558 for each step of the process. Times were recorded for initial registration, time of triage, time when patient was taken to treatment room, time of initial physician or P.A. contact, and time of final disposition. These times were recorded by the ER staff or the researcher as the patient moved through the system. All times were recorded in minutes. Data were also collected on

patient acuity, patient volume, consultations, admissions, staffing levels, and shift.

Each time period, the staffing numbers, and the patient volume were coded as continuous variables. The entries for labs, x-rays, consults, and admissions were coded as dichotomous data using binary notation. The data for patient acuity (emergent, urgent, and nonurgent) and shifts (shifts 1, 2, and 3) were mutually exclusive and categorically exhaustive.

The data obtained from this collection process were entered into the MICROSTAT statistics program. Descriptive statistics and correlation coefficients were calculated. Those variables showing a high correlation were analyzed using stepwise multiple linear regression. The dependent variable, total patient waiting time, was regressed upon each of the predictor variables. The stepwise regression allows reexamination, at each step, of the variables included in the model in previous steps. In the first step, the variable with the highest significant correlation is added to the model. At each step of the regression procedure, a partial F test is conducted for each variable currently in the model, treating the variable as if it were the most recent one entered, regardless

of when it was actually entered. The variable with the smallest nonsignificant partial F statistic (if such exists) is removed from the model and the model is reworked with the remaining variables. The process is repeated at each step on the basis of each variable's ability to improve the prediction of the dependent variable. Variables that were incorporated at an earlier step may in later steps become needless because of their relationship with other variables in the model. This process continues until no more variables can be entered or removed and the variables remaining in the model provide the best prediction of the dependent variable (Afifi & Azen, 1972).

The content validity of the SF 558 as a data collection instrument was assumed due the fact that it is a standard form used on a daily basis by the ER staff. The issue of the reliability of the data was addressed using the following measures. The ER clocks were used as the sole source for recording times to reduce inaccuracy from use of individual watches. The clocks were checked on a daily basis to ensure mutual agreement. It was stressed to the ER staff that no attempt would be made to associate any of the staff with delays in patient treatment. This was done to

avoid any bias in the recording of times by staff who might be fearful of being identified with delays. The author of the study spent as much time in the ER as physically possible to observe the process, monitor the recording of data, and ensure accurate and complete recording of the data.

All data identifying either patients or health care providers were omitted to protect their right to privacy.

Results

The analysis of the data set yielded the following information on demographics, utilization patterns, descriptive statistics, and inferential statistics.

The demographic characteristics of the population sample are shown in Table 1. The majority of the patients seen in the ER were in the 17 to 64 age category (60%); however, there is also a significant percentage of pediatric patients (35%). The largest beneficiary category was active duty dependents, representing 53% of the sample population. The descriptive statistics were calculated for the data set and the relevant means and standard deviations are shown in Table 2. The mean for total patient waiting time was 143.19 minutes with a standard deviation of

80.41 minutes. The data set also shows that 79% of the patients presenting to the emergency room were triaged as nonurgent, 20% were triaged as urgent, and 1% were triaged as emergent.

Twenty-nine percent of the patients required laboratory work, 24% required x-rays, 3% required additional consultation, and 3% were admitted to the hospital (note: these categories are not mutually exclusive). The average lab procedure had a turnaround time of 62 minutes, while the average turnaround time for an x-ray was 55 minutes.

Table 1

Demographics of the Sample Population

Age Category	Percent of Sample	Beneficiary Category	Percent of Sample
0-16	35%	Active Duty	26%
17-64	60%	AD Depn	53%
65 and older	5%	Retirees	8%
		Ret Depn	12%
Others	1%		

Table 2

Means and Standard Deviations

NAME	N	MEAN	S.D.
Time from Registration to Vital Signs/Triage	350	11.99	10.70
Time from Registration to Treatment Room	350	61.58	52.61
Time from Registration to First Physician/P.A. Contact	350	88.28	68.94
Total Waiting Time	350	143.19	80.41
Emergent Category	350	0.01	0.11
Urgent Category	350	0.20	0.40
Nonurgent Category	350	0.79	0.41
Patient Volume	350	129.00	18.91
Laboratory Procedures	350	0.29	0.46
Radiology Procedures	350	0.24	0.43
Consultations	350	0.03	0.18
Admission	350	0.03	0.17
# Physicians	350	1.96	0.85
# Nurses	350	2.02	0.78
# Physician Assistants	350	0.39	0.49
Shift 1	350	0.13	0.34
Shift 2	350	0.44	0.50
Shift 3	350	0.43	0.50

The correlation of the dependent variable with the
predictor variables identified six variables that had a
strong enough relationship to patient waiting time to
meet the critical value. The correlation coefficients
are listed in Table 3.

Table 3

Correlation Coefficients

Variable	r
Laboratory Procedures	0.41
Radiology Procedures	0.28
Consultations	0.16
Shift 1	-0.18
Shift 2	0.28
Shift 3	-0.15

Note. Critical value (2 tail, $r<0.05$) = +/- 0.10

These six variables were analyzed using stepwise
multiple regression. The regression resulted in three
of the six variables being removed from the regression
equation. The three variables remaining in the
equation were laboratory procedures, radiology
procedures, and consultations. The statistical test

value, degrees of freedom, and level of significance are listed in Table 4. The regression coefficients, standard error of the estimate, adjusted r squared, and r squared are given in Table 5.

Table 4

Stepwise Multiple Regression

Dependent Variable - Total Patient Waiting Time

Source	Sum of Squares	df	Mean Square	F	p
Regression	614838.04	4	153709.51	31.9	.0001
Residual	1661209.82	345	4815.10		
Total	2276047.85	349			

Table 5

Regression Coefficients

Variable	Regression Coefficient
Laboratory	61.17
Radiology	33.50
Consultation	36.98
Constant	115.67

Standard Error of the Estimate = 69.39
Adjusted R Squared = 0.26
R Squared = 0.27

These results demonstrate support of the alternate hypothesis, in that patient waiting time does vary as a function of at least three of the independent variables.

Discussion

The stepwise multiple regression analysis identified laboratory tests, radiology exams, and consultations as the best predictors of patient waiting time. These variables had the strongest statistically significant relationship with the dependent variable. When all the independent variables are taken into consideration, these three variables account for 27% of the variance in patient waiting time. The remaining independent variables did not have a statistically significant affect on patient waiting time.

The results of this analysis are consistent with the findings of previous studies. The statistically significant relationship between patient waiting time and laboratory tests, radiology exams, and consultations has been substantiated in studies by Smeltzer and Curtis (1986) and Wilbert (1984). The average patient waiting time of 143 minutes and the turnaround times for lab tests (66 minutes) and x-ray exams (55 minutes) are also consistent with the

findings of other studies (Smeltzer & Curtis, 1986,

1987; Wilbert, 1984; and Cue & Inglis, 1978). The lack

of a significant correlation between waiting time and

patient volume, patient acuity, time of day (shift),

and staffing is also found in the literature (Smeltzer

& Curtis, 1986; Wilbert, 1984; DiGiacomo & Kramer,

1982; and Goss, Reed, & Ready, 1971).

These results can be logically explained by the

fact that patients who require ancillary services, such

as laboratory tests, radiology examinations, and

consultations, are going to have longer stays in the ER

than those patients who do not require these

procedures. These three variables, singly or in

combination, will add one or more additional steps to

the treatment process, therefore increasing the total

waiting time.

The results also provided valuable information on

utilization and demographics. One of the more

interesting statistics on utilization was the

disproportionate number of nonurgent patients that

presented to the ER. Almost 80% of all ER patients are

triaged as nonurgent. These patients are using

valuable and expensive ER resources for conditions that

might very well be handled more appropriately in other

primary care settings.

Another interesting statistic on demographics shows that 35% of the patients in the ER are pediatric patient between 0 and 16 years of age. This information may indicate a need to expand pediatric clinic hours to accommodate the needs of these patients.

There are several limitations to this study. First, it was one of the original intentions of the study to capture the data on lab tests, x-ray exams, and consults as continuous data. However, during the data collection phase of the study, the ER staff failed to adequately document the times for these variables. This resulted in a high percentage of cases having incomplete or missing data for these variables and required that they be coded using binary notation. The turnaround times for lab tests and x-rays that were presented earlier were the averages for those cases that did have adequate documentation. A second limitation to the study is the patient volume variable. This variable represented the total number of patients seen in the ER during the 24 hour period of each day. Patient volume might have been more accurately represented by either the number of patients seen

during the shift or the hourly patient arrival rate.
Finally, caution should be exercised when attempting to
generalize these results to other hospital emergency
rooms. The data collected in this study represent a
two-week snapshot of the patients who presented to the
ER of a military hospital with a unique patient
population.

Conclusions and Recommendations

The results of this study provide the hospital and
the managers of the emergency room with additional
information to assist them in improving the services
provided in the ER.

The information on lab tests, x-ray exams, and
consults provides a basis for assessing these services
and procedures for possible improvement. Orders for
lab tests and x-rays coming from the ER are processed
as STAT requests (one hour turnaround time), and even
though the mean times for these procedures approximate
the one hour mark, there is still room for improvement.
There are times when orders for lab tests or x-rays
will stay on the counter of the nurse's station waiting
for someone to carry them to the lab or to escort the
patient to radiology. Likewise, there are times when
the completed lab results remain in the lab waiting for

someone to phone the results to the ER or carry them to the ER. Improving efficiency in these areas would result in decreased patient waiting time and would probably improve patient satisfaction.

The information on patient acuity indicates that the hospital, and specifically the ER, may need to look at alternative methods of treating the disproportionate number of nonurgent patients that are accessing the system through the ER. The ER currently runs a fast-track for nonurgent patients, but it is usually staffed by one physician and operates limited hours on weekdays. There may be a need to expand this program in order to more efficiently handle these patients.

The demographic information on pediatric patients indicates that there may be a need to expand these services also. A pediatrics after-hours clinic during the evening and on weekends might be a more appropriate way to treat this portion of the population.

The fast-track and the pediatrics after-hours clinic could both operate out of the Outpatient Clinic adjacent to the ER and could share any clerical or nursing support that might be required. These initiatives would free valuable ER resources to treat the more urgent cases. This would probably increase

the quality of care given to the patients and reduce medico-legal risk for the hospital.

Additional research in this area may provide more conclusive data on the variables affecting patient waiting time. Future studies should consider the limitations of this study. Greater effort should be made to incorporate lab tests, x-rays, and consults as continuous data. Patient volume might be represented more accurately as the number of patients per shift or the hourly patient arrival rate.

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